Fabrication and Testing of an Enhanced Ignition System to Reduce Cold-Start Emissions in an Ethanol (E85) Light-Truck Engine

Subcontractor

Nexum Research Corporation
Thermotech Engineering Division

Principal Investigator

David Gardiner
Thermotech Engineering
615 Norris Court
Kingston, Ontario K7P 2R9
Canada

DOE Project Manager

John Garbak
U.S. Department of Energy
CE-332, MS 6A-116/Forrestal
1000 Independence Avenue, SW
Washington, DC 20585
(202) 586-1723

NREL Technical Monitor

Peg Whalen
NREL
1617 Cole Boulevard
Golden, CO 80401-3393
(303) 275-4479

Subcontract Number

ACI-6-16602-01

Performance Period

11/95–2/97

NREL Subcontract Administrator

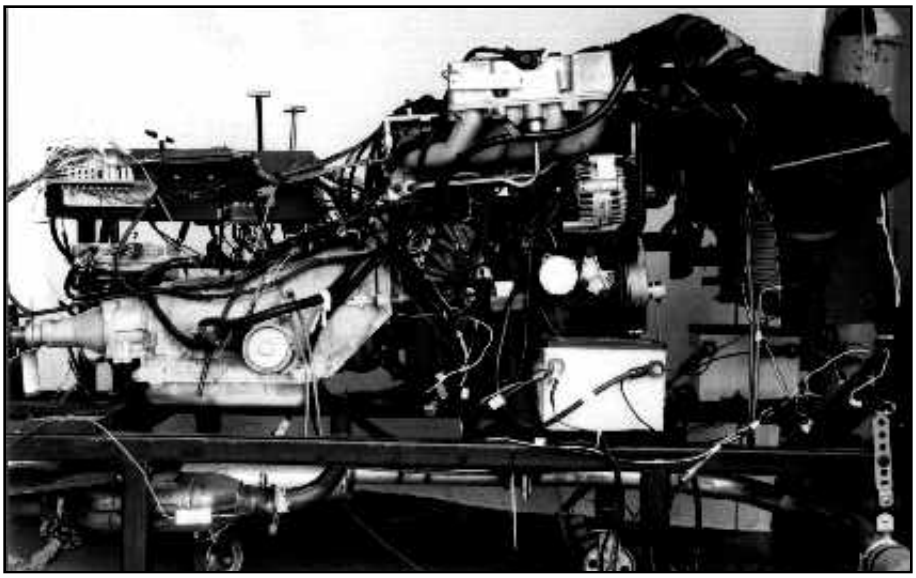
Kathleen Roque (303) 275-3124

Objective

To fabricate and test an enhanced ignition system that will reduce start-up emissions of high ethanol content (E85) fueled vehicles.

Approach

The enhanced ignition system being tested can be categorized as a low-energy plasma jet system. This ignition system concept was originally developed through funding from the Canadian Government (Natural Resources Canada).



Engine Test Bed

The enhanced ignition system is being employed as a means of stabilizing combustion under the adverse conditions present during start-up so that leaner fuel/air mixtures and later spark timing may be used. The engine tests being carried out in this study are designed to examine the potential trade-offs between engine-out exhaust hydrocarbon emissions, combustion stability, and exhaust temperature (as it affects catalyst light-off) over a range of fuel/air ratios and spark timing values.

General Motors of Canada Ltd. Product Engineering has provided a 2.2-liter, 4-cylinder engine test bed equipped with an ethanol-compatible fuel system and a user-programmable powertrain control module (PCM). The test bed has been modified to incorporate an external cooling system that can maintain the engine coolant temperature at 25°C during extended idle operation. Tests involving steady-state “force-cooled” operation at idle have been used as an expedient means of exploring the potential for ignition system and calibration changes to lower hydrocarbon emissions under the adverse conditions that exist for a cold engine.

Accomplishments

A 4-cylinder version of the enhanced ignition system has been fabricated and tested on the engine. The present system is configured to provide up to nine spark discharges per sequence with a stored energy level of 150 mJ per spark and a minimum re-strike interval of 60 µs. It has been demonstrated that by combining the ignition system with recessed surface-gap ignitors, the combustion stability of the engine under cold running conditions can be improved substantially relative to the case using the standard inductive ignition system and standard spark plugs. Tests to examine the effects of engine calibration variables have indicated that combinations of extremely late spark timing and slightly lean fuel/air mixtures can provide large reductions in engine-out hydrocarbon emissions during cold running.

Future Direction

Work is in progress to achieve a better trade-off between emission reductions and combustion stability through modifications to the enhanced ignition system and the fuel/air ratio control scheme. The performance of the standard ignition system will be characterized over an extended range of calibration values.

Publications

None to date.

Plasma Jet Engine - ignitor and spark current characteristics